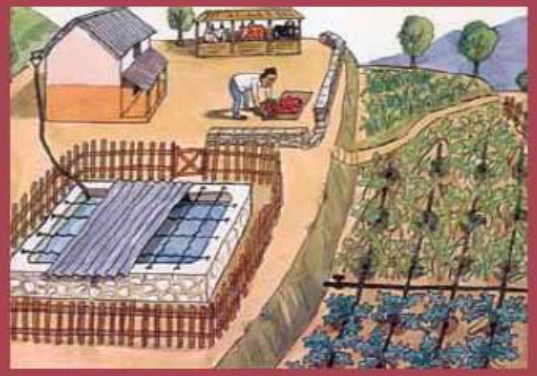
Low-cost Water Storage Tank Manual

Developed for
USAID/Nepal's
Education For Income Generation Program
(EIG)

February 2009



LOW COST WATER STORAGE

Appropriate irrigation technology for smallholder farmers

Ferro-cement Lined Tank

Installation Guidelines

CONTENTS

1. INTRODUCTION

IDE/Nepal spent three years conducting field research in the middle hills of Nepal to perfect the development of several low-cost water tank models. The introduction of these tanks has shown them to be both appropriate and useful for all rural household water storage needs. There are two basic design models – Modified Thai Jar (MTJ) and Ferro-cement Lined tank (FCL) – which range from 1,000-10,000 liter capacity. MTJ comes in sizes 1,000, 1,500, or 3,000 liter capacity and can be built either above ground or partially buried. FCL comes in sizes 6,000 or 10,000, is rectangular, and almost fully buried. Any water source can be collected in the tank, depending on the use and quality of water required. Most tanks in Nepal currently collect spring water from upland sources and/or rainwater.

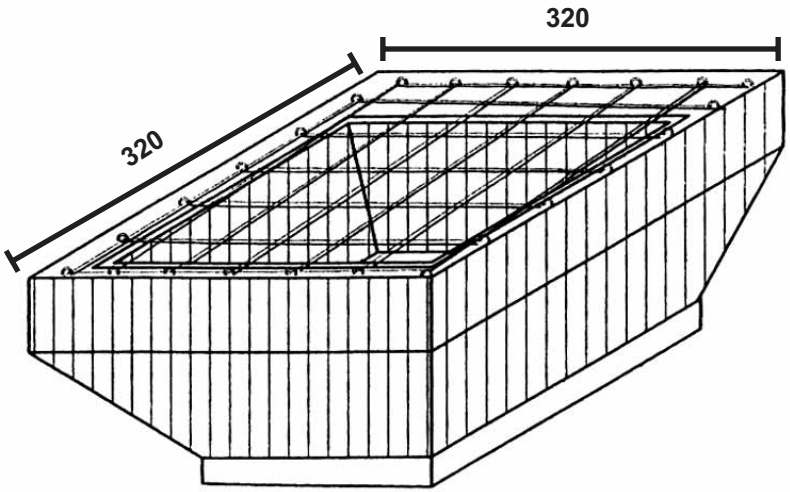
Type: Modified Thai Jar
Capacity: 1000, 1500 and 3000 litres

Type: Ferro-Cement Lined Tank
Capacity: 6000 and 10000 litres

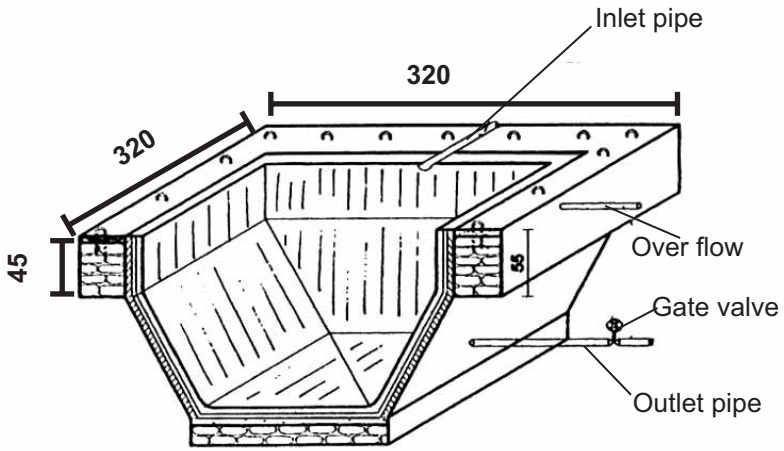
These guidelines describe the construction and maintenance process of the FCL tank and are primarily intended for local masons and construction technicians.

2. DRAWINGS

2.1 FCL - CAPACITY 6,000 LITERS



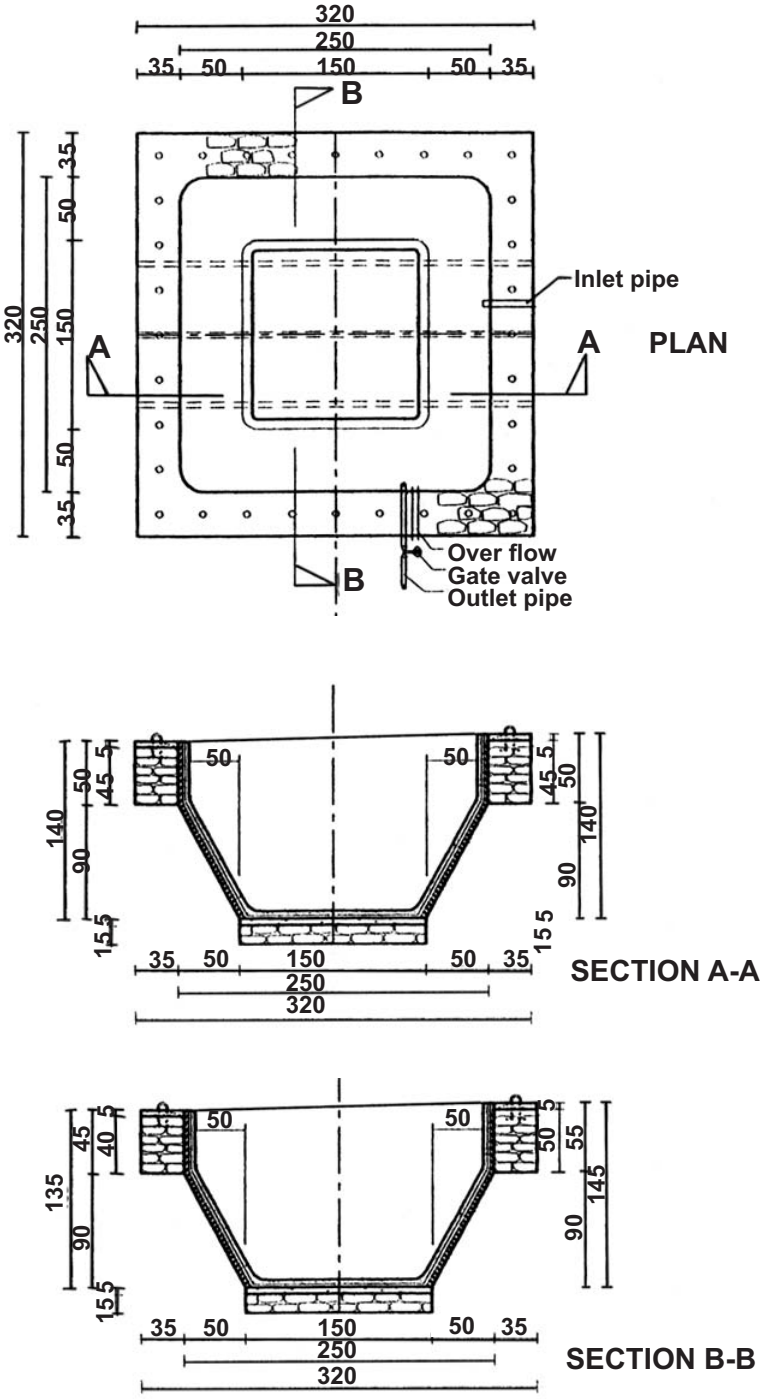
Isometric View



Sectional Isometric

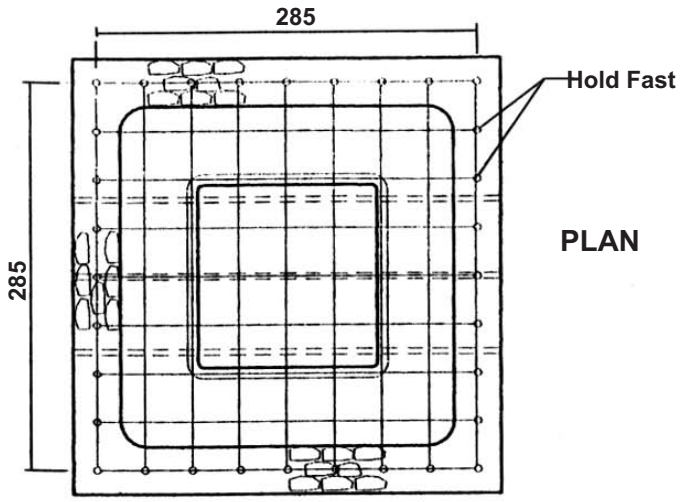
Note: All dimensions are in cm

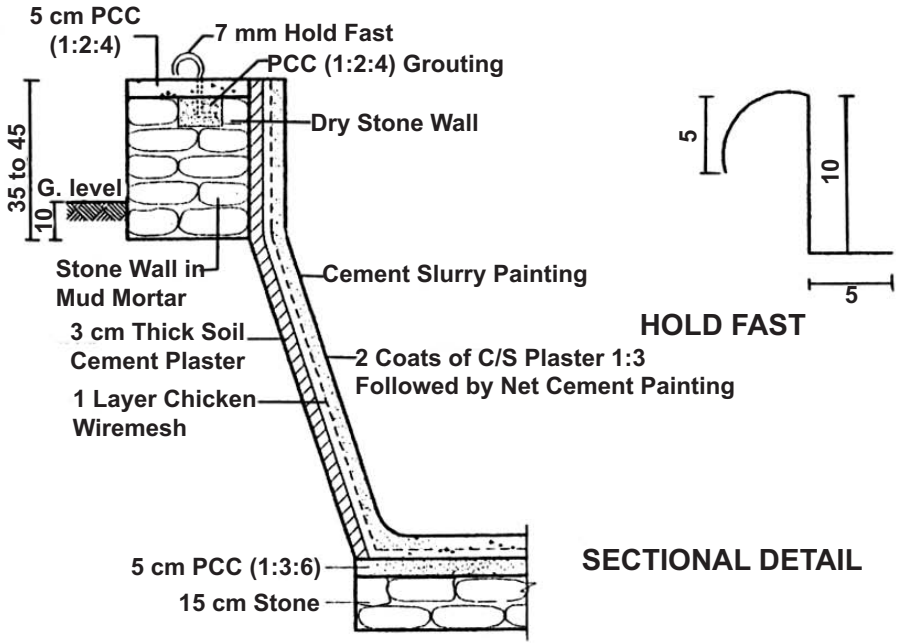
Isometric Views



Note: All dimensions are in cm

Plan and Section Views



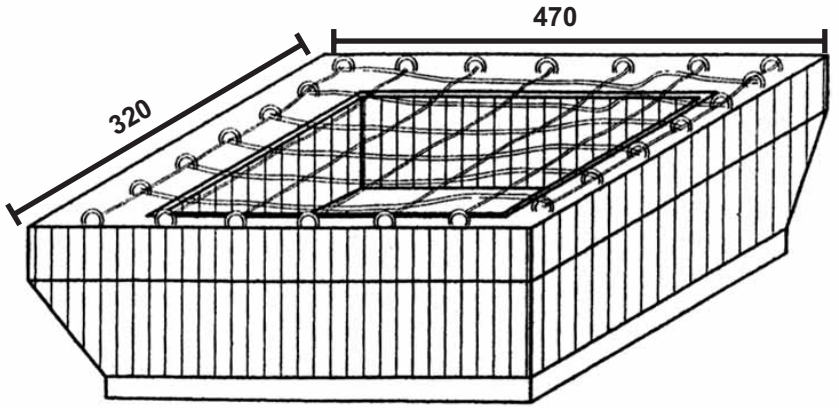


SCHEDULE OF STEEL REINFORCEMENT

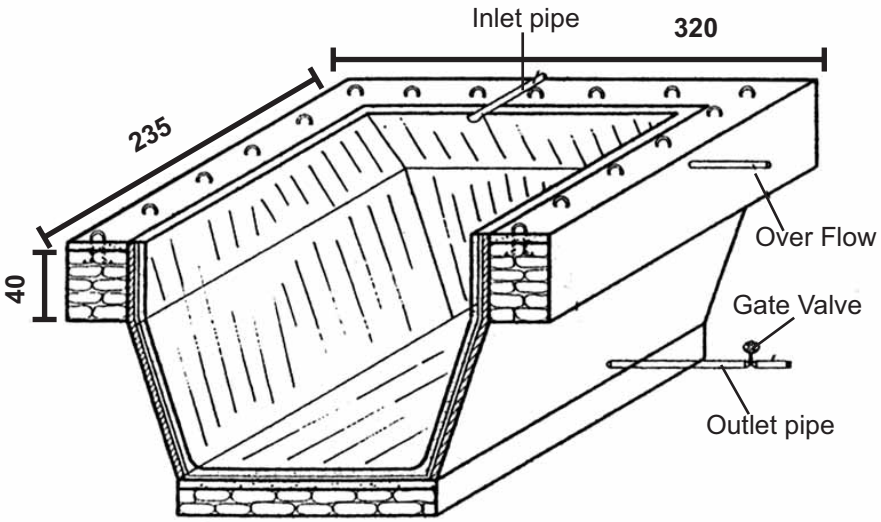
Component	Bar Code & Full From	Bar Shape	Bar Dia mm	Bar Type	Length cm	No.	Total Length cm	Weight kg
Roof Support	Hold Fast		7	TOR	25	32	800	2.40
14 12 Gauge GI Wire (Gabion Wire) for Roof Net								5.00
							Total	7.40

Plan and Section Views

2.2 FCL - CAPACITY 10,000 LITERS



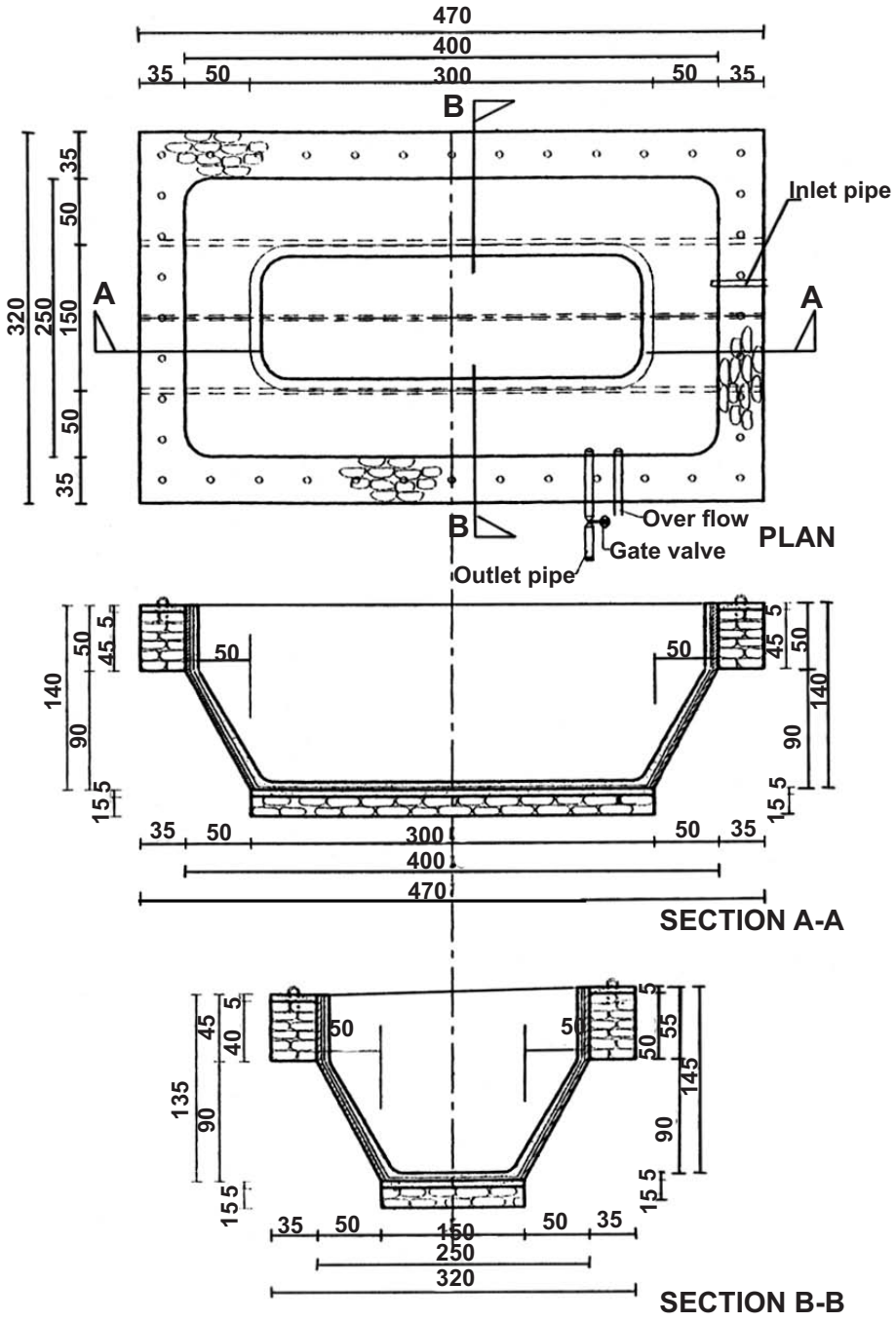
Isometric View



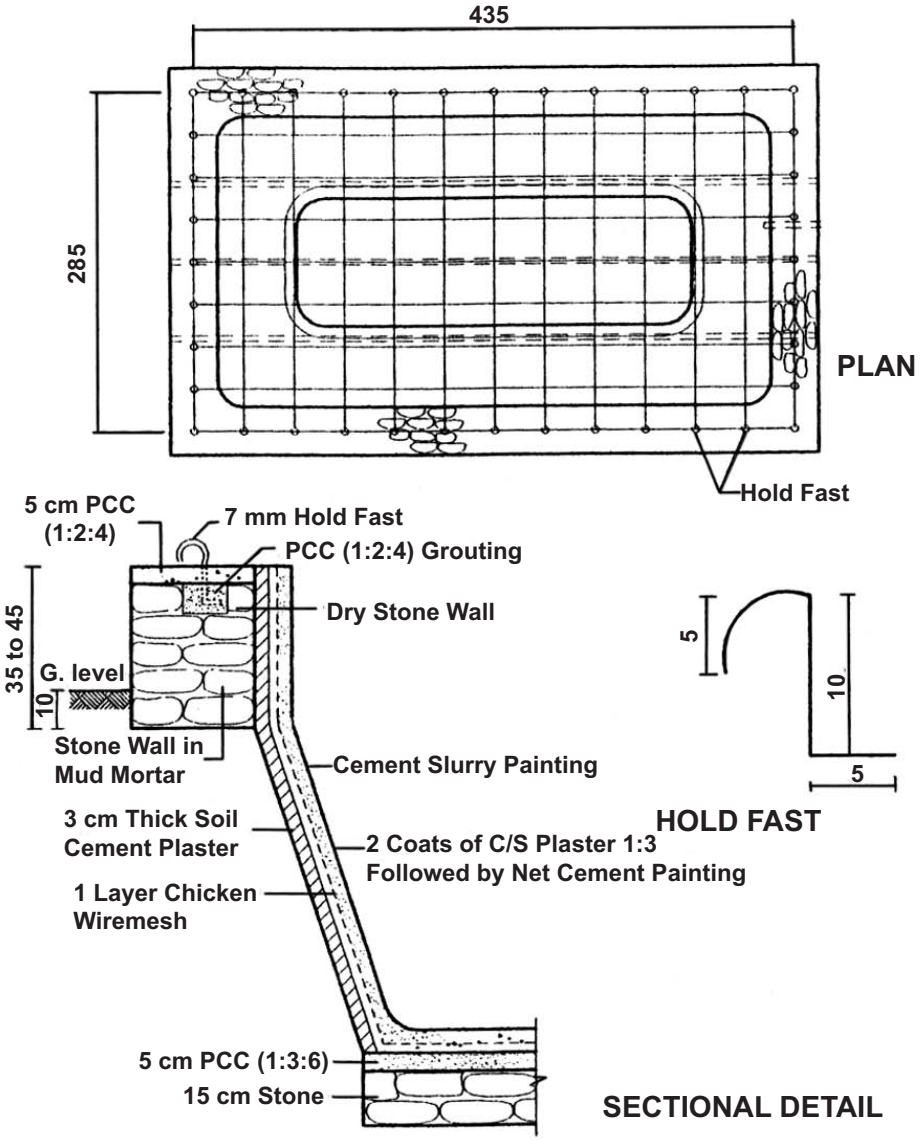
Sectional Isometric

Note: All dimensions are in cm

Isometric Views



Note: All dimensions are in cm



SCHEDULE OF STEEL REINFORCEMENT

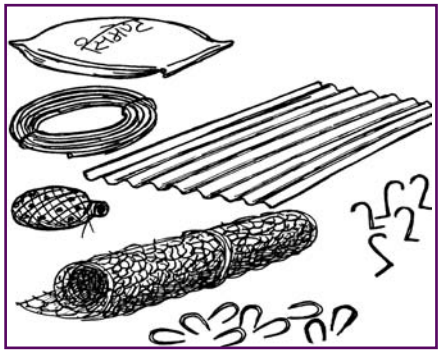
Component	Bar Code & Full From	Bar Shape	Bar Dia mm	Bar Type	Length cm	No.	Total Length cm	Weight kg
Roof Support	Hold Fast		7	TOR	25	42	1050	3.15
14 12 Gauge GI Wire (Gabion Wire) for Roof Net								8.00
							Total	11.15

3. TANK COST ESTIMATES

Component	Unit	Rate (NRs)	6,000 liter FCL		10,000 liter FCL	
			Qty	Total	Qty	Total
DIRECT CASH COMPONENT						
Cement	Bag	500	6	3,000	8	4,000
8# Gabion wire	Kg	61	8	488	9	549
Chicken wire mesh	m^2	45	20	900	25	1,125
Pipe fittings	Set	700	1	700	1	700
Filter	No.	150	1	150	1	150
Mason wage	NRs/ day	500	11	5,500	15	7,500
Tools	Lump sum	500	1	500	1	500
28# CGI Sheet	Bdl	7500	0.75	5,625	1	7,500
Hold Fast	No.	12	42	504	56	672
U-Nails	Kg	55	4	220	5	275
SUB TOTAL				**17,587**		**22,971**
NON-CASH COMPONENT						
Stone	ft^3	22.7	35	794	50	1,134
Sand	ft^3	28.4	25	709	35	992
Gravel	ft^3	31.2	8	249	10	312
Unskilled labour	NRs/ day	200	20	4,000	25	5,000
Bamboo, rope, water	Lump sum	125	1	125	1	125
SUB TOTAL				**5877**		**7563**
GRAND TOTAL				**23,464**		**30,534**

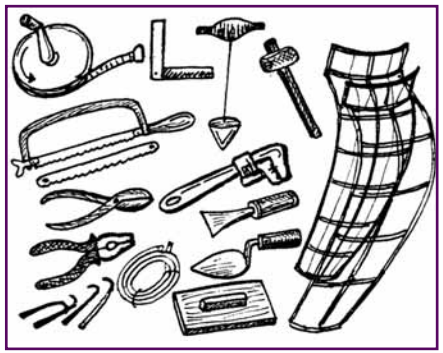
Note: Above material rates are based on the Kathmandu market price. Prices may vary regionally due to transportation costs.

4. MATERIALS AND TOOLS REQUIRED



Manufactured materials

Local materials



Tools supplied by mason

Tools supplied by owner

5. CONSTRUCTION STEPS

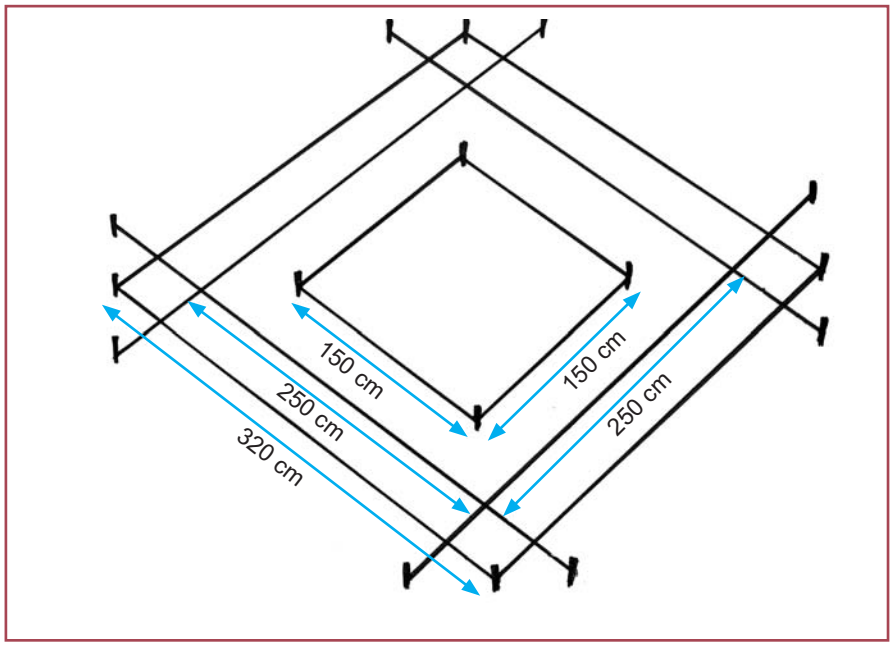
5.1 SITE SELECTION

For the 6,000-liter tank, choose a site of 4 meters x 4 meters.
For the 10,000-liter tank, choose a site of 4 meters x 5.5 meters.
The other criteria for the site selection are:

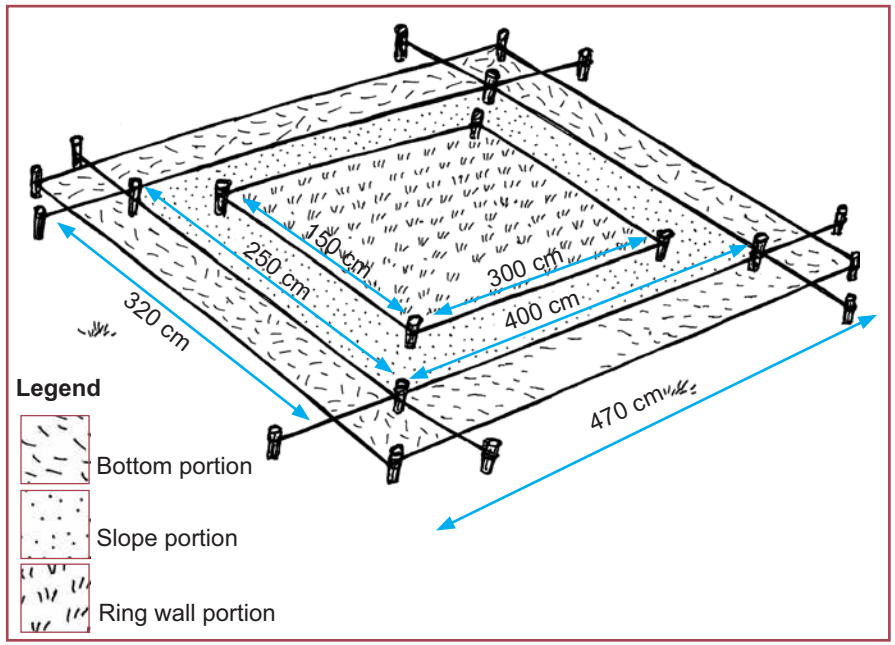
- Close to the water source
- Suitable for roof water collection (if required)
- Stable ground free from threat of a landslide or land settlement
- Not prone to damage by flooding
- Easy to divert overflow and waste water
- Appropriate for use with microirrigation (height and distance from the field)

5.2 FOUNDATION EXCAVATION

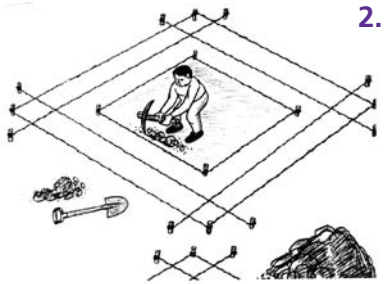
1. Mark the foundation layout as per the following diagrams.



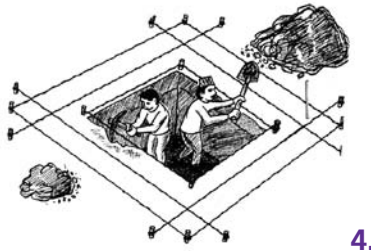
6,000-liter FCL



10,000-liter FCL

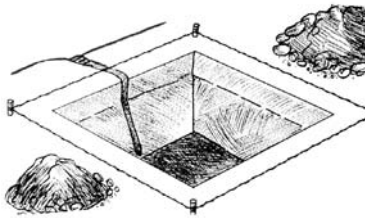


2. Start digging from the "bottom" portion of the layout to a depth of 60 cms. Haul the excavated earth at least 3 metre away from the tank.



3. Cut the slope and keep the excavated material in the same place as in step 2.

4. Excavate remaining portion of the slope and the bottom and store the excavated soil separately for drying. This soil can be used for preparation of soil cement mortar.



5. Dig a 40 cm wide and 30 cm deep trench to make the ring wall.

6. Make a 35 cm wide trench to house the outlet pipe.

5.3 CONSTRUCTION OF RING WALL / SETTING HOLD FASTS

1. Construct a 35 cm thick stone or brick wall (ring wall) in mud mortar around the periphery of the tank.

2. Anchor the hooks with cement concrete spaced at 30 cm intervals all along the ring wall.

5.4 STONE SOLING ON THE FLOOR AND LAYING THE OUTLET PIPE

1. Lay dry stones in the foundation and compact them with iron rammers until they have a thickness of approximately 23 cm.

2. Lay the outlet fittings and fix them into the cement concrete mix. Cover the open ends of the outlet until the construction of the tank is complete.

5.5 PREPARATION OF THE SOIL CEMENT MORTAR

1. Dry the selective earth (minimum 60 cm below the ground) and grind it finely to a powder form.
2. Pass the earth powder through a screen with 1-2 mm sized holes.

3. Mix the cement, sand and the screened soil in 1:3:8 ratio.

Cement

Sand

Soil

4. Pour water in the dry mix equal to the volume of the cement required.

5. Mix the ingredients thoroughly to make a homogenous mortar.

5.6 CEMENT APPLICATION

1. Apply soil cement mortar on the vertical face and the slopes.

2. Lay 5 cm thick plain cement concrete (ratio 1:3:6) on the floor of the tank.

5.7 FIXING THE CHICKEN WIRE MESH

Wait for 12 hours after cement application. Then unwind the roll of the chicken wire mesh. Stick it on the wall and the floor by fixing the U-nails.

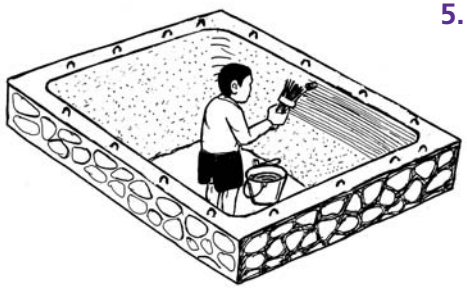
5.8 PLASTERING

1. Apply first layer of cement sand plaster on both the wall and floor of the tank interior. This layer of the plaster has to be roughly finished for better grip with the finishing layer of the plaster.

2. Apply second layer (final layer) of the cement sand plaster just over the first layer using the cement mortar of the same ratio as in the first layer.

3. Prepare a new batch of cement mortar in 1:6 ratio (cement: coarse sand). Lay the mortar on the top portion of the ring wall.

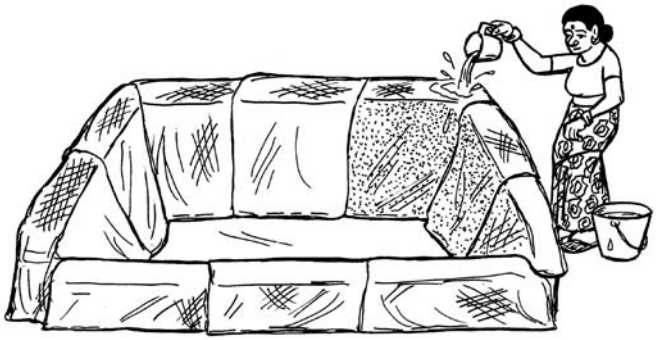
4. Apply cement pointing on the outer face of the ring wall.



5. Prepare strong cement slurry (1 part cement: 4 part water) and apply it over the entire plastered surface including the top of the ring wall.

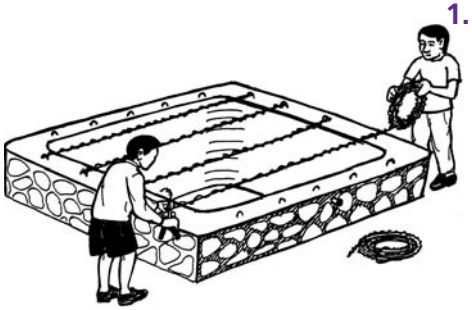
5.9 CURING

Curing of cement elements is the process of preventing fast dehydration of the structure which will negatively effect the strength attainment. The common way of curing is to cover the structure and keep it moist for a few weeks after construction. After completion of tank construction, it must be kept moist for at least one week to properly cure it.

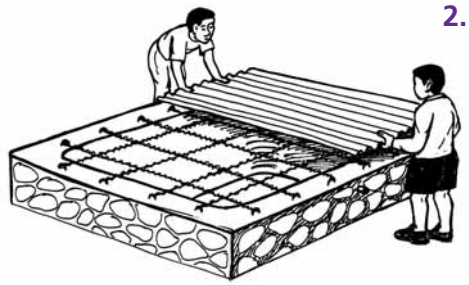


Curing

5.10 ATTACH GABION WIRE AND ROOFING SHEET



1. Use the hooks on the ring wall to create a square grid pattern of gabion wire across the top of the tank (connect the wire between opposite rings both horizontally and vertically). Make the wires adequately straight to prevent the roofing sheet from sagging.



2. Fix the corrugated iron roofing sheet over the gabion net.

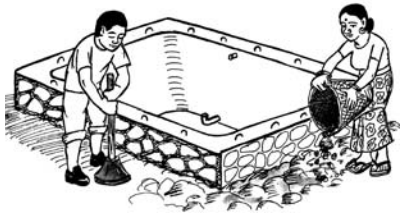
5.11 LEAK TEST

To test for leaks, water is filled into the tank to two different heights and the vertical height of the water column is measured.

1. **Half-full tank test:** One week after the completion of the construction, fill the tank half full. Measure the initial height of water. Cover the tank to prevent evaporation and leave it for 24 hours. Then measure the height of the water again. If there is an decrease of water depth, locate the point of the leak and seal the leak using cement plaster.

2. **Full tank test:** If the tank is found free of leaks in the half-full test, fill it with water up to the top and perform the same leak test procedure again.

5.12 BACK-FILLING



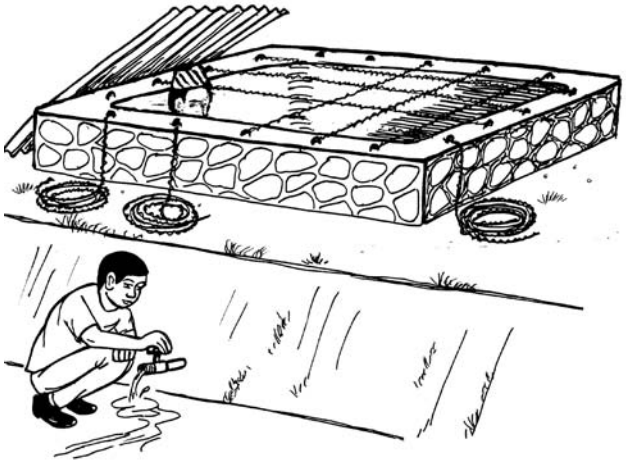
Once the tank is finished and has been tested for leaks, backfill the foundation with earth and compact it to stabilize. It is suggested to provide turf or stone pitching along the periphery of the tank. Make sure to provide an area for drainage water around the tank by making a surface drain with an adequate slope for diversion of water to gullies or crop fields.

6. MAINTENANCE AND REPAIR

6.1 CLEANING THE TANK AND FILTER

The tank must be cleaned at least once per year. Depending on the amount of deposited sediments, it may need more frequent cleaning. Tanks need to be cleaned whenever the height of the sediment deposit exceeds 5 cm and approaches the outlet height. It is recommended to clean the tank during pre-monsoon and post-monsoon months. Two people are required for tank cleaning.

Fill the tank with water to a depth of 30 cm. Use a wooden stick to create turbulence with the sediments in the tank. Open the washouts and gate valves and drain the dirty water. Continue this process until the tank is completely clean. Upon completion of cleaning, close the washout and outlets.

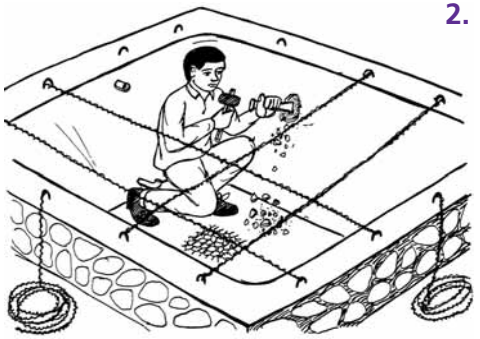


Cleaning the tank

Cleaning the filter

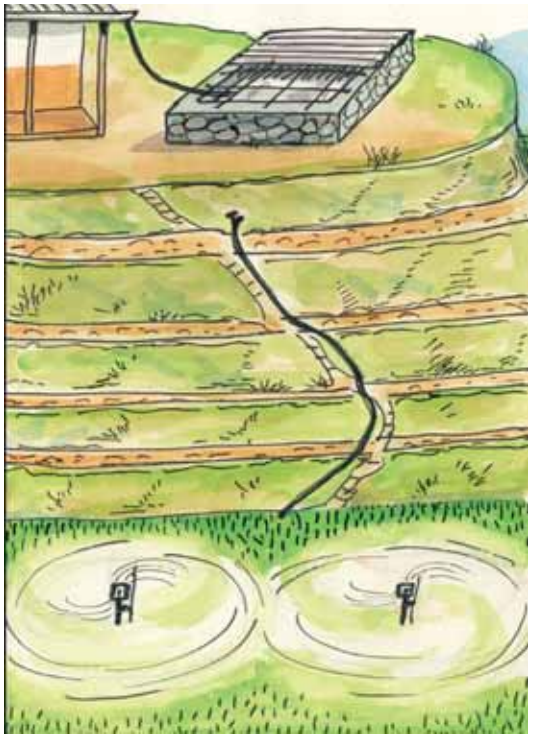
6.2 LEAK REPAIRS

1. **Finding leaks:** Examine the inside surface of the tank and detect the spots where there are holes or cracks.



2. **Creating a hole:** Chisel up to 5 cm around the crack or hole.

3. **Plastering:** Cover the crack with chicken wire mesh. Then apply two layers of cement sand plaster. Last, paint over the cement sand plaster with cement slurry. Repeat steps 1-3 for each crack and hole.



FCL Tank integrated with micro-irrigation